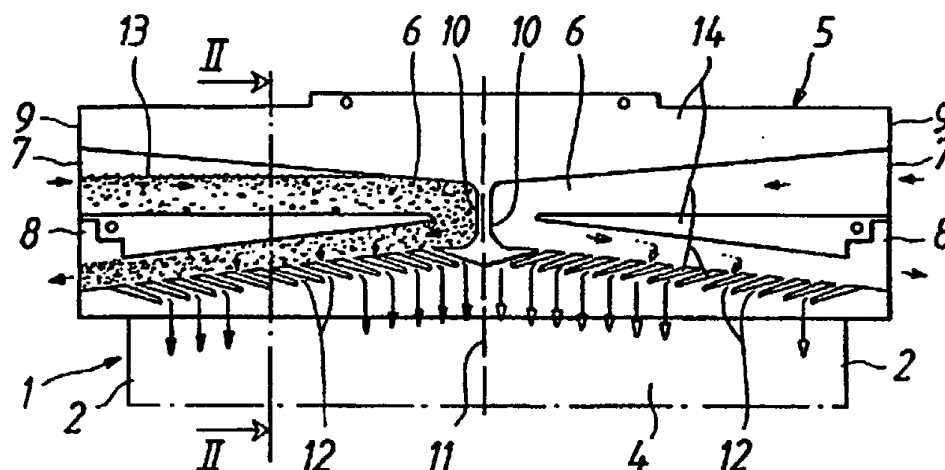




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>6</sup> : <b>B01D 1/30, 1/22</b>	<b>A1</b>	(11) International Publication Number: <b>WO 95/08381</b> (43) International Publication Date: 30 March 1995 (30.03.95)
(21) International Application Number: PCT/FI94/00423 (22) International Filing Date: 21 September 1994 (21.09.94) (30) Priority Data: 934143                      22 September 1993 (22.09.93)      FI (71) Applicant (for all designated States except US): OY SHIPPAX LTD. [FI/FI]; Mustionkatu 4, FIN-20750 Turku (FI). (72) Inventor; and (75) Inventor/Applicant (for US only): KORDELIN, Tapio [FI/FI]; Kalminkuja 16, FIN-20900 Turku (FI). (74) Agent: BERGGREN OY AB; P.O. Box 16, FIN-00101 Helsinki (FI).	(81) Designated States: AU, BG, BR, CA, CN, HU, JP, KR, NO, RO, RU, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  Published With international search report.	

(54) Title: FLUID DISTRIBUTOR OF A MEMBRANE DISTILLER AND THE USE OF THE DISTILLER



## (57) Abstract

The invention is directed to the liquid distributor of a membrane distiller and to the use of a membrane distiller provided with such distributor. The membrane distiller comprises a number of bag-like distillation elements (1) of membrane material which operate by evaporating the liquid conducted to the outer surfaces (4) of the elements using the heat transfer from the steam condensing inside the elements and in which the generated steam is recycled through a compressor into heating steam inside the elements, the heating steam being condensed into a distillate obtained as the end product. The liquid distributor consists of batten (5) at the upper end of distillation element (1), provided with parallel feeding channels (12) for distributing the vaporizable liquid on the outer surface (4) of the element. According to the invention batten (5) contains main channel (6) transversal to element (1), parallel feeding channels (12) leading to the surface (4) of the element being branched from the main channel. Part of the liquid flow can be led past the feeding channels to outlet (8) of the main channel. A turbulence is generated in the liquid flow of main channel (6) to prevent the blocking of feeding channels (12), whereby the distiller is adapted to be used for the evaporation treatment of fiber suspension (13), for instance, according to the invention.

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FLUID DISTRIBUTOR OF A MEMBRANE DISTILLER AND THE USE OF THE DISTILLER

5 The object of this invention is the fluid distributor of a membrane distiller, comprised of a batten at the upper end of a bag-like distilling element made of membrane material, the batten comprising parallel feeding channels for distributing vaporizable liquid transversally on the outer surface of the  
10 element.

The membrane distiller is a device comprised of flat bag-like elements placed against each other and made of thin membrane material such as plastic membrane. The heat transfer is carried  
15 out inside the elements from condensing steam through the membrane to the vaporizable liquid running along the outer surfaces of the elements. The heating steam is steam which is generated on the outer surfaces of the elements and fed inside the elements through a compressor to be condensed into the  
20 distillate obtained as the end product of the process.

A typical use of a membrane distiller has been the production of fresh water from sea water. In addition, it has been recently applied to evaporation treatments of suspensions containing  
25 solid matter.

Publication print FI 86961 discloses a distillation element of a membrane distiller comprising a honeycomb-structured end batten at its upper end, the feeding of vaporizable liquid to the outer  
30 surfaces of the element being carried out from the end batten. The batten is provided with parallel inclined feeding channels starting from one end thereof, the feeding channels being in contact with a fluid container on the side of the elements and distributing the vaporizable liquid along the whole width of the  
35 element surface. In addition to these fluid feeding channels, the battens also contain steam channels for the steam pressurized by the compressor and entering the elements.

In parallel fluid feeding channels of the batten formed of

honeycomb board according to the above-mentioned known solution, which are of the same width but of different lengths with respect to each other, pressure loss is increased with the length of the channels when moving from the side of the element on the side of said fluid container towards the opposite side of the element. This results in that the distributing of liquid in the transversal direction of the element is uneven while the first-mentioned side, where the liquid channels are shorter, receives more liquid than the opposite side of the element, the liquid channels leading to the opposite side being longer. In addition, it has been proven that when evaporating liquid suspensions containing solids, parallel feeding channels starting from the container are blocked very easily.

The purpose of this invention is to form a batten-like liquid distributor of a membrane distiller, containing parallel feeding channels, in which said drawbacks of known solutions are avoided. The invention is characterized in that the batten situated at the upper end of the distillation element contains the transversal main channel of the element, the parallel feeding channels leading to the surface of the element branching from the main channel.

In the solution according to the invention the main channel can be formed essentially wider than the feeding channels of approximately the same length branching from it, whereby the main channel distributes liquid evenly to the feeding channels, the liquid spreading out on the surface of the element as an essentially even transversal front. It has been further noticed that a turbulence generated in the main channel can be used to prevent blocking of the feeding channels, making the solution especially suitable for the evaporation treatment of liquid suspensions containing solid particles.

According to a particularly advantageous embodiment of the invention, the main channel is led through the batten so that it distributes part of the liquid flow to the feeding channels while the rest exits through the outlet of the main channel. When treating liquid suspensions containing solids, the

turbulence generated by the liquid flow of the main channel has been proven to keep the solid particles mainly in the flow of the main channel where they end up in the outlet of the channel without getting to the membrane surfaces of the distillation elements through the feeding channels. Mainly only the liquid phase is separated in the feeding channels and on the surfaces of the elements. Another advantage in addition to the feeding channels remaining unblocked is that the need to clean the elements is decreased.

10

It furthers the above if the main channel is essentially evenly wide and slightly inclined downwards and the feeding channels are branched diagonally backwards from the main channel.

15 Regarding the even distribution of the vaporizable liquid, it is preferred to construct the batten forming the liquid distributor so that it comprises two main channels situating in different halves of the element, and that the feeding channels branching from each main channel are orientated towards the vertical  
20 centre line of the element. Thus the inlets and outlets of the main channels can be situated in the opposite ends of the batten, while each main channel is deflected by a bend of about 180° near the centre line of the element, whereby the feeding channels are branched from the main channel in the portion  
25 between said bend and the outlet of the main channel. The flow in the main channel can effectively cause turbulence effectively with the aid of the bend situated in the main channel before the branching points of the feeding channels. The purpose of the orientation of the feeding channels is to ensure that no dead  
30 space without liquid remains in the middle of the element.

It is preferable to connect the liquid distributor according to the invention to the bag-like distillation element as an integral end batten. The batten can also comprise, in a manner  
35 known per se, steam channels leading inside the element. On the other hand, it is possible for the batten-like liquid distributor according to the invention to form, in the membrane distiller, an element separate of the bag-like distillation elements.

Another object of the invention is the use of the membrane distiller provided with the above-described liquid distributors according to the invention in evaporation treatment of liquid suspensions containing solid particles, especially fiber suspensions such as the waste liquor from pulping. We refer to Claims 9 and 10 with respect to these applications of use.

The invention is described in the following in more detail with the aid of an example with reference to the appended drawing in which:

Fig. 1 shows the upper end of the bag-like distillation element of the membrane distiller with its batten serving as the liquid distributor, as viewed from the front, and Fig. 2 shows the upper ends of two adjacent distillation elements with their liquid distributing battens, as section II-II of Fig. 1.

Distillation elements 1 according to the drawing are included in the membrane distiller which can comprise a large number of mutually similar elements placed against one another according to Fig. 2. Each element 1 comprises a bag formed by two membrane layers 4 joined to each other using spot welds 3 or the like and joined together by edges 2 thereof, and end batten 5 transversal to the element and situated at the upper end of the element, serving as the liquid distributor. Batten 5 is intended to feed, onto membrane surface 4 forming the outer surface of the element, the liquid which is evaporated by the effect of the heat transfer from the condensing steam fed inside the element between the membrane layers. The steam formed on membrane surfaces 4 of the elements is used as heating steam and recycled inside the elements through a compressor (not shown).

End batten 5 of the element serving as the liquid distributor contains sets of channels in the left and right halves of the element which are mirror-images of each other according to Fig. 1. Each set of channels comprises wider main channel 6 whose inlet and outlet 7, 8 are situated at the end 9 of the batten, the main channel being deflected by bend 10 of about 180° in the vicinity of the vertical centre line (dashed line 11 in Fig. 1)

of the element. Main channel 6 is evenly wide and slightly downwards inclined between bend 10 and outlet 8, and in this span a number of feeding channels 12 leading to membrane surface 4 of the element are branched from it in a comb-like manner, the feeding channels being of the same mutual length and orientated diagonally backwards from the main channel towards said centre line 11 of the element. Fig. 1 shows the flowing of vaporizable fiber suspension 13 in the left-hand channels, while the right-hand channels are only provided with arrows illustrating the flowing.

In practice, the same liquid suspension is naturally fed to the membrane surface of the element from both sets of channels.

The purpose of liquid distributor 5 shown in the drawing is to provide as even as possible distribution of vaporizable liquid on membrane surface 4 of the element. Another purpose is to enable the evaporation treatment of liquid suspensions such as fiber suspension 13 containing solid particles, utilizing the turbulence caused by the streams in main channels 6, preventing the blocking of feeding channels 12 branching from the main channel, in accordance with observations.

The illustrated batten-like liquid distributor 5 can be manufactured from plastics, for instance, by tying formed pieces 14 limiting main channels 6 and feeding channels 12 between two opposite plastic sheets 15 (cf. Fig. 2). It is also possible to connect the steam channels leading inside elements 1 to batten-like liquid distributor 5, the steam channels not being shown in the drawing being unessential to the invention. It is further possible to include, in the liquid distributor, common or separate sets of liquid channels which feed liquid to both membrane surfaces 4 of the same element 1. In the solution according to Fig. 2 each liquid distributor 5 feeds liquid to opposite membrane surfaces 4 of two adjacent elements 1. Liquid distributors 5 of adjacent elements are drawn at a small distance from each other in Fig. 2 for the sake of clarity, but in practice they are pressed against one another during the operation of the distiller.

It is clear to those skilled in the art that different applications of the invention are not limited to the above-described example but can vary within the appended Claims.



## CLAIMS

1. A liquid distributor (5) of a membrane distiller consisting of a batten at the upper end of a bag-like distillation element (1) made of membrane material, the batten comprising parallel feeding channels (12) for distributing vaporizable liquid transversally on the outer surface (4) of the element, characterized in that the batten (5) contains a main channel (6) transversally to the element (1), parallel feeding channels (12) leading to the surface (4) of the element being branched from the main channel.

2. A liquid distributor according to Claim 1, characterized in that the main channel (6) runs through the batten (5) so that it distributes part of the liquid flow into the feeding channels (12) while the rest exits through the outlet (8) of the main channel.

3. A liquid distributor according to Claim 2, characterized in that the main channel (6), from which the feeding channels (12) are branched, is essentially of even width and inclined slightly downwards.

4. A liquid distributor according to Claim 2 or 3, characterized in that the feeding channels (12) are branched diagonally backwards from the main channel (6).

5. A liquid distributor according to any of the preceding Claims, characterized in that the feeding channels (12) are essentially of the same mutual length.

6. A liquid distributor according to any of the preceding Claims, characterized in that the batten comprises two main channels (6) situated in different halves of the element (1) and that the feeding channels (12) branching from each main channel are orientated towards the vertical centre line (11) of the element.

7. A liquid distributor according to Claim 6,

c h a r a c t e r i z e d in that the inlets and outlets (7, 8) of the main channels (6) are situated in the opposite ends (9) of the batten (5), each main channel being deflected by a bend (10) of about 180° near the centre line (11) of the element, whereby the feeding channels (12) are branched from the main channel in the portion between said bend and the outlet (8) of the main channel.

8. A liquid distributor according to any of the preceding Claims, c h a r a c t e r i z e d in that the batten (5) is an integral part of the bag-like distillation element (1).

9. The use of a membrane distiller for evaporation treatment of liquid suspension (13) containing solid particles, in which the feeding of vaporizable liquid to the outer surfaces (4) of the bag-like distillation elements (1) made of membrane material is effected from the batten-like liquid distributors (5) at the upper ends of the elements, each liquid distributor including at least one main channel (6) transversal to the element and led through the distributor and parallel feeding channels (12) leading to the surface of the element and branching from the main channel.

10. The use of the membrane distiller according to Claim 9 for the evaporation treatment of a fiber suspension (13).

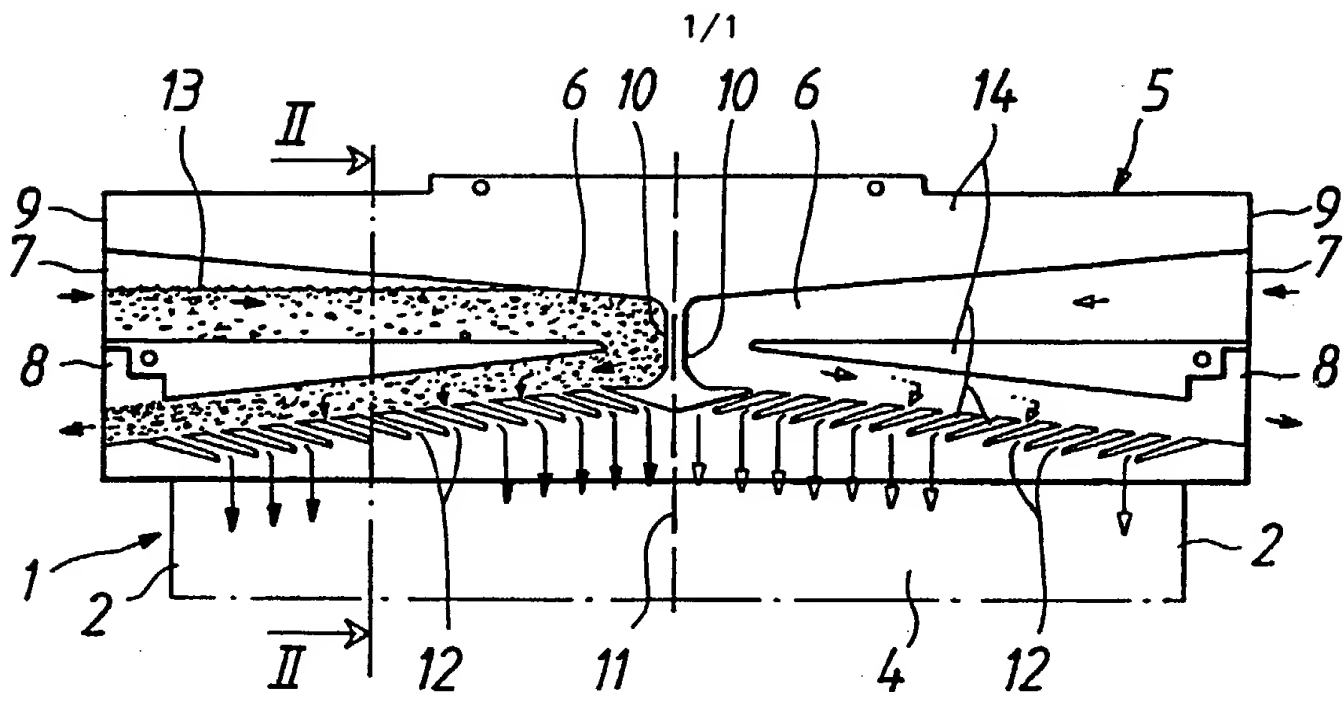


Fig. 1

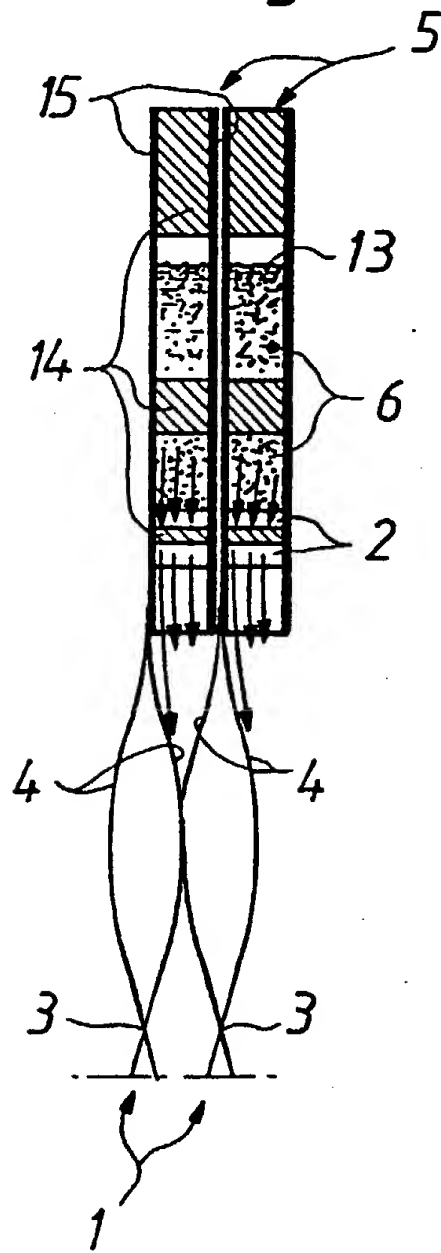


Fig. 2

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 94/00423

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B01D 1/30, B01D 1/22

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 3724522 (JOHN T. POGSON), 3 April 1973 (03.04.73), figure 2 --	1
A	FR, A1, 2591504 (CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE), 19 June 1987 (19.06.87), page 7, line 14 - line 34, figure 2 -- -----	1

☐ Further documents are listed in the continuation of Box C.
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Date of the actual completion of the international search

22 December 1994

Date of mailing of the international search report

09 -01- 1995

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**INTERNATIONAL SEARCH REPORT**  
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Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US-A-	3724522	03/04/73	US-A- 3738410	12/06/73
FR-A1-	2591504	19/06/87	NONE	